



Femtocells in the Home

Briefing Paper



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TABLE OF CONTENTS

1 INTRODUCTION.....	3
2 THE CASE FOR FEMTOCELLS	4
3 FEMTOCELL CONSIDERATIONS AND CHARACTERISTICS.....	6
4 CONCLUSIONS.....	8





Introduction

Femtocells are aimed at providing high performance 3G voice and data communications in and around the immediate home environment. Connected to the Operator's mobile network over existing broadband connections in the home, femtocells have the potential to make indoor coverage for mobile communications truly pervasive while delivering additional benefits to both the Operator and end-user.

The femtocell network architecture provides Operators with a complete indoor coverage solution, all in a small, low-cost, low-power, easy-to-install base station that can be seamlessly integrated into existing mobile networks and provisioned for service within minutes of switching it on. Such platforms enable a host of new applications and revenue opportunities, and provide Operators with the means to compete in the home market, increasing minutes of use and ARPU in the fixed mobile convergence market.

Motorola's femtocell solutions draw upon our extensive experience in collapsed architectures, IP developments and RF techniques to deliver solutions that enable localised 3G coverage, in doing so freeing-up capacity in the macro layer and enabling an attractive 'cost per bit' of data delivery.

This paper outlines the drivers, benefits and principles of this new and exciting technology development.

The Case for Femtocells

Operators face significant challenges with the deployment of new technology, new applications and the ever increasing usage demands placed upon mobile networks. At the forefront of these challenges is making 3G coverage as "near ubiquitous" as practically possible, both outdoors and indoors.

The traditional 3GPP 3G network architecture, made up of numerous macro base-stations, with its centralized RNC function and ATM backhaul was designed to provide wide-area coverage. It was not however designed to scale, physically or economically, to provide effective coverage for individual indoor/residential situations.

It is common knowledge within the mobile telecommunications industry, that the use of outdoor macro-cells to provide indoor/residential coverage quite simply does not provide an effective solution, from both a coverage and economic perspective in addition to considering practical matters, such as site acquisition, which is becoming increasingly problematic.

Not only is site acquisition costly, forming a major proportion of network build-out costs, it is also very time consuming with many local authorities closely regulating the sale and usage of potential cell-sites. Assuming suitable sites can be acquired, increasing cell-site density through the use of smaller cells, may not overcome all coverage issues but will lead to increased backhaul costs and other practicality issues.

Additionally, any significant in-building usage of high-bandwidth data services degrades the macro network as the power allocated by the base-station to provide in-building coverage would likely compromise the overall service delivery in the rest of the cell.

People are becoming increasingly reliant on their handset device to the extent that it forms "part of their identity"; similarly more and more people would prefer one number and one device to handle all their communications needs be it in the home or elsewhere. A recent survey (commissioned by the mobile content backup services provider, FusionOne, Inc. (October 10, 2007) found that over 50% of respondents indicated that their social lives would "suffer" if their mobile were to go missing.

Many end-users use, indeed prefer to use, their mobile phone when in the home, even where a fixed-line telephone is available. People have become accustomed to and take for granted the convenience that the mobile phone provides in terms of mobility and in having a single device to communicate that includes their contacts and even takes and stores their messages in a variety of formats.

3G signals, operating at very high frequencies (2100MHz) and high bandwidths also mean that they have a poor ability to penetrate through structures. This often leads to service quality and an end-user experience that does not meet end-user expectations and can lead to dissatisfaction, reduced minutes of use, increased customer churn and ultimately, lost revenues.

Most end-users of 3G services invariably have to 'make-do' with the coverage provided by the macro base-station serving their location at that point in time, whether stationary out in the world, in a building or while on the move. The issues associated with providing coverage for indoor situations from macro base-stations are well known; 3G and buildings, or to be precise their fabric, are inherently not a good mix.

Most Operators agree that a significant portion of all calls made from mobiles are initiated when the end-user is indoors; it then becomes understandable why providing good indoor coverage is essential in order to provision cost effective, high-quality and higher-performance wireless voice and data services to their end-users when inside their homes.

Femtocell solutions will deliver a dedicated coverage solution for indoor/residential situations providing Operators with a complete solution: a small, low-cost, low-power, easy-to-install 3G "base-station" that can be integrated and provisioned into existing macro networks very quickly and will support existing 3G handsets and devices. Femtocells will also likely drive the uptake of 3G services, especially in the home environment, overcoming the issues of poor coverage and price premium associated with mobile device usage compared to fixed-line offerings.

For end-users, the benefits of femtocells include a seamless communication experience as they roam from the indoors to the outdoors, potential preferential "in-home" tariffs, improved indoor and dedicated coverage, a single bill and all without impacting their use of existing 3G handsets and devices.

Since late 2006 interest in femtocell solutions has increased to the extent that most industry analysts suggest femtocell deployment will become widespread in the coming years; "In Europe, 30 to 40 percent of the cellular traffic is generated from inside the home. Femtocells provide a more efficient way for operators to manage traffic generated indoors, compared to the outdoor macrocells of the public cellular infrastructure," commented Vincent Poulbere, principal analyst, Ovum. "In Western Europe, we forecast that 12 million femtocells will be deployed in 2010 rising to 17 million in 2011." Many other analysts have expressed similar views; femtocell solutions offer great opportunities to the Operator and end-user alike.

Having considered the major drivers for femtocell deployment, the following section looks at some of their practical aspects.

Femtocell Considerations and Characteristics

Femtocells overcome the issue of providing effective indoor coverage from the 3G macro layer by their placement in the end-users' homes. Once installed in an end-user's home a femtocell will enable the Operator to provide higher-quality and higher-performance wireless voice and 3G data services in and around the immediate vicinity of the home environment.

Femtocell products are in many ways similar to Wi-Fi access points in that they enable access through an unobtrusive device; however femtocells enable full 3G service delivery in the home. Similar in size to a DSL gateway or cable modem, a femtocell is a low capacity base-station, radiating only sufficient power to cover the area of a home environment. The femtocell connects to the Operator's core network using open 3GPP based standards through the end-user's household broadband internet connection rather than traditional cellular backhaul methods.

Accordingly femtocells must also fulfill a number of other criteria:

Low-impact – Space may be limited for some households. As a result femtocells must be physically small, ideally aesthetically pleasing and easy to position. Furthermore, they should also be silent in operation, generate low levels of heat output and inexpensive to run in terms of on-going [electricity] costs.

Low RF power – The transmit RF power output of femtocells is low; between 10 and 100 milli-watts. Put in perspective, this is a lower power level than many Wi-Fi access points, which can be specified up to 1 Watt of output power. Additionally, by being close to the femtocell the 3G handset is itself able to transmit at lower power levels than it might otherwise have to when on the macro network.

Capacity – Femtocells are aimed at delivering dedicated 3G coverage to a household and in doing so can provide a very good end-user experience within the home environment. As a result, femtocells have a design "capacity" of up to 6 end-users.

Low-cost – There is significant competition for access solutions in the home space. Wi-Fi is commonplace, easy to install/configure, provide a very good benchmark in terms of performance, and are highly cost effective. Femtocells will be offered for purchase via their Operators. This may be direct or through resellers.

Energy offset - Low-power consumption – Clearly if the end-user is to foot the bill for the electrical energy consumed by the femtocell base-station then this figure must be low enough not to raise concerns as to its impact on the fuel bill. That said, from an Operator’s perspective, this OPEX is effectively offloaded, which makes the business case for femtocells even more attractive.

Easy end-user installation – Like cable modems and DSL routers, femtocells will be installed by consumers and activated through service providers. This means that the Operator no longer has to employ installation teams or have a truck-roll every time a new femtocell is “deployed”. From the end-user perspective the unit must be a simple “plug and play” installation with a minimal amount of intervention required.

Backhaul via broadband– Femtocells utilize Internet protocol (IP) and flat base-station architectures. Backhaul connection to Operator networks will be through wired broadband Internet service existing in the home such as DSL, cable, or fiber optics as available. There are no connections required to the wider cellular network other than through the IP core. This will benefit Operators by effectively offloading traffic that would otherwise be on the macro-layer directly onto the internet from the femtocell; this not only reduces the load on the core network but also lowers the cost of delivering wireless traffic when compared to the macro network.

Interference - The use of femtocells in spectrum also currently used by the macro layer may, if not managed correctly, give rise to issues with interference between cells; macro with femtocell and in the instance of close proximity of two or more units, femtocell with femtocell. Operators will likely want to launch femtocells on the same channel as their macro cell network for capacity reasons.

Handovers - Current macro RF planning techniques are inappropriate for femtocells. Not least because of the sheer potential numbers of femtocells and managing the neighbor lists that would be necessary. Also the potential to “ping-pong” between layers, especially as an end-user moves around the home and enters into areas where the signal strength from the macro-cell is greater than that of the femtocell, must be considered very carefully to ensure that the networks provide the best overall coverage without issue. To illustrate, in macro based 3G networks the overhead associated with soft-handovers accounts for a significant proportion of RNC processing capability. Understandably then and in order not to exacerbate the issue, great care and sophisticated algorithms are necessary to overcome these potential issues and ensure that the over-all network quality is not impacted by inefficient handovers and wasted capacity.

Security - Given the requirements for low-cost and easy installation, the use of the broadband internet as the network interface becomes very easy to understand. However this raises security risks in that broadband internet has open access. There are various approaches to address this issue including the embedding of the lub interface within the IP signaling itself while network security is managed by the IP security (IPSec) protocol.

Worldwide cellular network standards support – Understandably femtocell products are likely to appeal to many end-users around the world. As a result differing models will be developed and offered to satisfy the various needs from the different regions. Products will offer support for their respective and existing (3GPP) UMTS and (3GPP2) CDMA standards, as well as emerging standards such as WiMAX, UMB and LTE.

Support for existing 3G handsets and devices –Support for existing handsets and devices is a very important consideration for the end-user and Operator alike, not least because of the cost of changing devices if that were necessary. In each technology market, femtocells will support existing handsets and devices further helping to drive uptake of 3G services and femtocells in particular.

Operation (transmit/receive) in Operator-owned spectrum – Femtocells operate in licensed spectrum owned by Operators and may share the same spectrum (currently the 2100MHz frequency band) with the macro network.

Operator controlled – Femtocells operate in licensed spectrum and as such Operators must ensure that they comply with the conditions of that license and any other controls enforced by a regulator. To these ends femtocells feature client software that enables remote configuration and monitoring via an Operations, Administration, Maintenance and Provisioning (OAM&P) system in a similar manner to that used by the macro network.

New services and applications – Femtocells are likely to become an integral part of managing all communications in and out of the home environment. Femtocells enable Operators to cost-effectively offer in-home pricing and integrate mobile services into triple-play / quad-play service offerings. Femtocell architectures include provision for a services environment on which applications may be added, thereby facilitating new revenue opportunities.

Service Assurance – Remote Management to enable an operator to provide the end-user quality of service at the edge of the network.

Conclusion

Considering that the majority of “mobile” calls originate in the home and end-users prefer to use a single handset – their mobile, Operators now have focused solutions available to them that overcome the issues of poor in-building coverage. Previously, attention to indoor coverage was on the Enterprise market with micro- and pico-solutions supplementing the macro layer in order to provide hot-spot and high capacity for offices, airports, shopping malls, etc. Until now, providing good coverage for homes has largely been overlooked.

That is changing. Femtocells will provide a one-box solution: a small, low-cost, low power unit that can be self-installed to provide mobile 3G coverage to the home. For the end-user femtocell solutions will provide dedicated and reliable mobile 3G coverage in the home with opportunities for preferential tariffs. For the Operator, femtocells deliver cost effective coverage where the business-case or practicalities of deploying a macro base-station might not be feasible.

Once in the home, the femtocell is likely to encourage end-users to use their mobile as their single communications device irrespective of their location. Femtocell solutions are also likely to increase minutes of use and revenues per user and also open up brand-new revenue streams through the integration of mobile services into triple-play and quad-play service offerings. Furthermore, by adopting a femtocell solution, Operators can easily add 3G mobile with in-home usage tariffs to a bundled mobile and broadband offering without the macro-layer bearing the increased load.

Motorola is renowned for its expertise in providing end-to-end solutions across all environments. This is especially true of indoor and residential solutions. Early on Motorola recognized and highlighted the need for improved 3G coverage in in-building situations; our femtocell solutions now provide the opportunity to extend that coverage into the home, provide an excellent end-user experience and in doing so help to further drive the uptake of 3G service adoption.

Solutions however are not simply about only technology; they are about capabilities and delivery. To these ends, Motorola is the number one provider of gateways and broadband customer premises equipment (CPE) globally and leads the market with its end-to-end CPE management solution, a key facet in any network. Finally, Motorola has a global presence supported by local knowledge meaning that wherever our services are required we will be there.

Motorola has already conducted extensive systems testing of our femtocell solutions and is currently undertaking a number of customer field trials around the world; commercial deployments are expected soon after the trials have been concluded.

Motorola’s breadth of capabilities allied to market leading femtocell coverage solutions will provide innovative, comprehensive indoor coverage solutions for the home environment to the world’s Operators.



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